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DETERMINING THE FACTOR STRUCTURE OF THE PSYCHOPATHY CHECKLIST: A CONVERGING APPROACH

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ABSTRACT

Three statistical and six psychometric methods were used to obtain converging validation of the correct number of factors to extract in the Psychopathy Checklist. A two-factor solution was obtained reflecting, respectively, criminal/antisocial behaviors and salient personality characteristics of the psychopath. The present results support the two-factor interpretation proposed by Templeman and Wong (1987) and Harpur, Hakstian, and Hare (1988). Earlier factor analytic studies which suggest a five to seven-factor solution are probably the result of an overextraction of factors. A converging approach in determining the correct number of factors to retain is strongly encouraged.

INTRODUCTION

Hare (1980), Raine (1985), Kosson, Nichols, and Newman (1990), Harpur, Hakstian, and Hare (1988), and Klinteberg, Humble, and Shalling (1992) carried out factor analytic studies of the Psychopathy Checklist (PCL), a valid and reliable instrument for the assessment of criminal psychopathy (Hare, 1980, 1985). Although certain consistencies exist in the factors extracted by different investigators, there are still disagreements regarding the number of factors to extract and the composition of the extracted factors. These are important issues that have to be resolved if the factors underlying the PCL are to be used to identify the global trait of psychopathy.

A part of the data was presented at the 1987 Annual Meeting of the Canadian Psychological Association. Correspondence may be addressed to Dr. S. Wong, Department of Psychology/Research, Regional Psychiatric Centre, Box 9243, Saskatoon, Saskatchewan, Canada S7K 3X5.

REVIEW OF THE FACTOR ANALYTIC STUDIES

Hare (1980) factor analyzed the 22-item PCL based on a sample of 143 male inmates and identified five factors accounting for 61% of the total variance. Raine (1985) attempted to replicate the above study using a sample of 122 male English inmates and extracted seven factors with eigenvalues greater than one. However, only 3 of the 6 factors can be judged to be equivalent (Ten Berge, 1986). Kosson et al. (1985) extracted six principal components based on a sample of 120. They suggested that the six factors were similar to Hare's five factors, although no statistical test of similarity was done.

Harpur et al. (1988) factor analysed data from six inmate samples (N = 1119)[1] using a split half cross validation method (Everett, 1983) and analyses of congruence coefficients. A two factor solution was replicated in all six samples.

The lack of close agreement between the factor solutions of different researchers can be attributed to a number of possible reasons. First, with the exception of Harpur et al. (1988), the sample sizes in the reported studies are small and this may lead to unstable factor solutions. Comrey (1973), Cattell (1978), and Gorsuch (1983) suggest a minimum sample size of at least 200 cases.

Second, there is no unique factor solution to any data set. As well, there is no one generally acceptable method to determine the correct number of factors to retain (Hakstian & Muller, 1973). Notwithstanding, researchers have typically relied on only one method and this may lead to either an over or under extraction of factors.

The present study uses nine different methods (three statistical and six psychometric methods) to obtain converging validation of the correct number of factors to retain. The randomly selected sample (N = 315) also satisfies the sample size requirements suggested by Comrey (1973), Cattell (1978), and Gorsuch (1983).

SUBJECTS AND PROCEDURE

The subjects were a randomly selected sample of 315 male penitentiary inmates representing 15% of the federal inmate population in the provinces of Alberta, Saskatchewan and Manitoba. They came from maximum, medium and minimum security institutions. Ratings on the 22-item PCL (Hare, 1980) were done independently by two raters using file information alone. It has been shown that comprehensive file information alone can be used to obtain reliable psychopathy ratings and accurate classification of inmates into psychopaths and non-psychopaths (Wong, 1988). The average of the two ratings was used to compute the final rating. The mean age of the sample was 30.38 (SD = 7.61). Interrater reliability (Pearson productmoment correlation) was .85; coefficient alpha and mean ratings for the PCL were .85 and 25.34 (SD = 5.85) respectively.

The statistical analyses were done (except where specified) using the BMDP-4M Factor Analysis program and SPSS-X on the University of Saskatchewan VAX 8600 computer. Unless specified, Principal Factor Analysis was used in factor extraction. Direct oblimin rotation with Delta set to zero was used in all the rotations of the factors.

STATISTICAL METHODS TO DETERMINE THE NUMBER OF FACTORS

BARTLETT'S TEST

In Bartlett's Test (Bartlett, 1950, Gorsuch, 1983, p. 150; Mulaik, 1972, p. 177) the correct number of factors to retain is determined when the p-value for the Chi-square reaches non-significance. The results suggest at least 13 significant factors. Gorsuch (1983, p. 154) suggested that Bartlett's and most of the other statistical tests tend to overextract factors. The results of these tests, however, can delimit the upper bound of the number of factors to retain (Gorsuch, 1983, p. 156).

PARALLEL ANALYSIS CRITERION

The Parallel Analysis Criterion was first proposed by Humphreys and Ilgen (1969) to determine the number of factors to retain, and was validated by Montanelli and Humphreys (1976) using simulated random data. In the present analysis, eigenvalues of the experimental and random correlation matrices were extracted and plotted as a function of the ranking of the eigenvalues as in a Scree Plot. The point of intersection of the two lines gives the number of factors to retain.

A prerequisite of the above analysis is that the experimental correlation matrix has to be statistically significant (Gorsuch, 1983, p. 156). The experimental correlation matrix was shown to be highly significant (Chi-square = 2408, df = 231, $p < .001$) using Bartlett's Test. The Parallel Analysis Criterion yielded an eight factor solution (see Figure 1). At present, there is no available statistical test to determine if significant differences exist between the random and experimental eigenvalues in factors one to eight. As such, the Parallel Analysis Criterion method is only useful to determine the upper bound of the number of factors. Visual inspection of the results suggests that only two of the eight factors are probably non-random factors.

MAXIMUM LIKELIHOOD METHOD

The Maximum Likelihood Factor Extraction Method (Lawley & Maxwell, 1963) compares the similarity of the reproduced and the experimental correlation matrix using a Chi-Square goodness of fit test. A significant difference between the two correlational matrices would suggest that additional factors have to be extracted. The first occurrence of a non-significant ($p > .05$) Chi-square represents the correct number of factors to retain which is eight for the present analysis. The above analysis was done using SAS statistical package (SAS Institute, 1985).

Mulaik (1972, p. 169) indicated that this procedure tends to overextract factors when the sample size increases. As with most statistical tests, as n increases, it is more likely to obtain significant results with small differences. Harmon (1976, p. 206) suggested this test should be used with large samples in order not to violate the distribution assumptions of multivariate normality.

Bentler and Bonett (1980) suggested another way of using the Chi-square derived from the Maximum Likelihood Test to determine the number of factors to retain. The Normed Fit Index (Delta), a non-statistical test of significance,

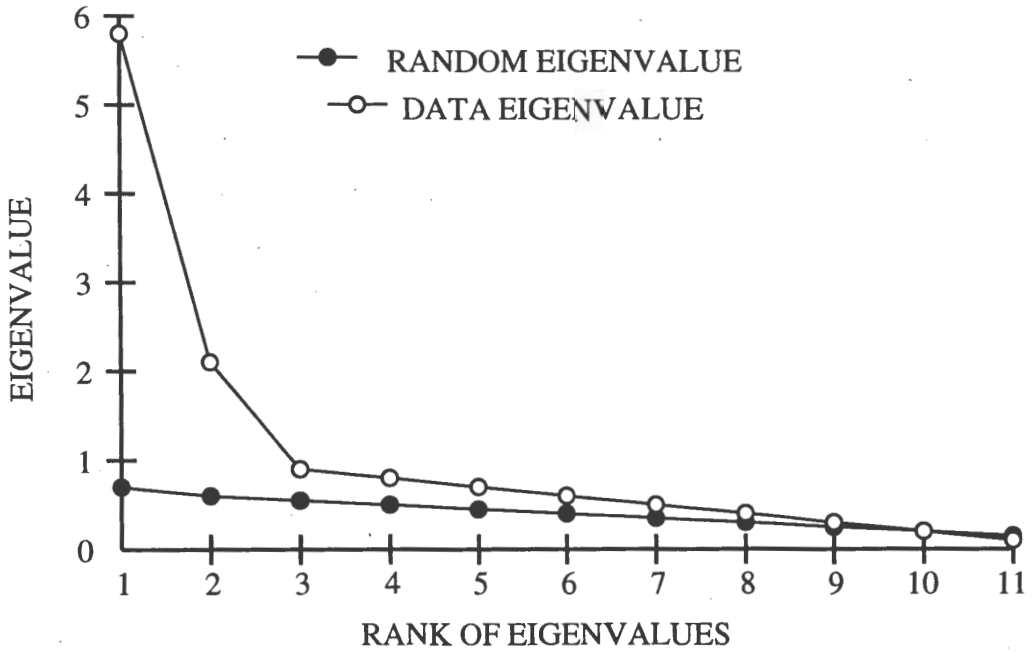

Figure 1. Eigenvalues of the data and the random correlation matrices as a function of the ranking of the eigenvalues.

measures the goodness of fit of a factor model. The Chi-square for the zero factor solution (X), and for an m factor solution (Y), where m is the number of factors extracted, were obtained as in the Maximum Likelihood Test. The Deltas were calculated as (X-Y)/X. A Delta value above 0.8 can be considered as suggesting that sufficient factors have already been extracted. The Normed Fit Index suggests a three factor solution.

PSYCHOMETRIC METHODS TO DETERMINE THE NUMBER OF FACTORS

KAISER-GUTTMAN CRITERION

The Kaiser-Guttman or Kaiser criterion can be used in two ways to determine the correct number of factors to retain: the eigenvalue-1 and the eigenvalue-0 criteria. Guttman referred to them as the "weakest and the strongest" form respectively to determine the lower bound for the number of factors to retain (Gorsuch, 1983, p. 161). Six and 11 factors were extracted using eigenvalue-1 and eigenvalue-0 criteria respectively.

Gorsuch (1983, p. 162) argued that the eigenvalue-0 and 1 criteria may lead to a serious overextraction of factors because computations are not based on population correlation matrices.

SCREE TEST

The Scree Test is the plot of the magnitudes of eigenvalues against their ranks. Based on visual inspection, the remaining factors not in the scree are the number of factors to extract.

Inspection of the scree plot suggests that two well defined factors can be extracted. The Scree test has been shown to overextract or underextract factors under different conditions (Hakstian, Rogers, & Cattell, 1982). However Gorsuch (1983, p. 169) suggests that it is more likely for the scree test to underextract factors.

MATRIX OF PARTIAL CORRELATIONS (MAP) TEST

The MAP test (Velicer, 1976) should be used with Principal Components Analysis or as a first stage in a factor analysis to determine the number of non-trivial components as opposed to merely statistically significant components. The MAP test progressively extracts an increasing number of principal components. Residual matrices are obtained by taking the difference between the experimental correlation matrix and the reproduced correlation matrix derived from the components extracted. The analyses suggest a two factor solution. This procedure tends to underestimate the number of factors if in error (Gorsuch, 1983, p. 155).

VERY SIMPLE STRUCTURE (VSS) METHOD

Revelle and Rocklin (1979) argued that the proper number of factors to extract are those factors that maximize simple structure. To maximize the simple structure, all except the largest element in each row of the factor pattern matrix are replaced by zeroes. A reproduced correlation matrix is then computed based on the simplified factor pattern. The VSS index is a function of the residual matrix.

The results show a one factor solution. The VSS tends to underextract factors because of the very strict criterion used to approximate simple structure.

Table 1 is a summary of the results of the nine different methods used to determine the correct number of factors to retain in the PCL. As indicated earlier, the statistical methods as well as the Kaiser Criterion one and zero methods tend to overextract factors. They could provide an estimated upper bound for the number of factors to retain which should be between six to eight factors. Raine's (1985) seven factor and Kosson et al. (1985) six factor solutions appear to be the result of an overextraction of factors. Hare's (1980) five factor solution, though less than the upper bound, may have the same trend.

Results of the VSS test suggest a one factor solution, probably due to applying very stringent simple structure requirements to the factor pattern matrix. The true number of factors in the solution should be somewhere between two to five. Harpur et al. (1988) using the Factor Comparability method suggested a two factor solution; so do the Scree and MAP tests. The Norm Fit Index suggests a three factor solution. Given the weight of evidence is in favour of a two or three factor solution, a three factor solution (see Table 2) was obtained as a first approximation.

TABLE 1

SUMMARY OF THE NUMBER OF FACTORS EXTRACTED USING NINE DIFFERENT METHODS

Statistical Methods:	Number of Factors
1. Bartlett's Test	> 13
2. Parallel Analysis Criterion	8/2#
3. Maximum Likelihood Method	8
Psychometric Methods:	
4. Kaiser Criterion-0	11
5. Kaiser Criterion-1	6
6. Normed Fit Index	3
7. Scree Test	2#
8. Velicer's Map Test	2
9. Very Simple Structure Test	1

#visual inspection

FACTOR RELIABILITY

The next step is to determine the reliability of the three factors. Extracted factors are considered reliable if the regression of the items on the factor scores of each factor have a multiple R-square value greater than .7 (Tabachnick & Fidel, 1983). The magnitude of the sum of square loadings (SSL) can also be used as a measure of reliability. When the SSL is over one, the factor can be considered reliable (Tabachnick & Fidel, 1983). Factors one and two are highly reliable, but factor three is only marginally reliable (see Table 3) based on the above reliability criteria.

Only two items (13 and 18) load highly on factor three, and they measure very similar things: early behavioral problems and juvenile delinquency. Comrey (1978) indicated that significant but trivial factors may be extracted when items closely resembling each other are included in a test. Factor three is likely such a factor. Comrey (1978) suggested re-entering the mean value of the two similar items and re-extracting one less factor. The re-extracted two factor solution is given in Table 2. For comparison purposes, the loadings on items 13 and 18, based on the solution using all 22 items are shown in parentheses. The two factors are highly reliable factors (see Table 3) based on both criteria of reliability (Tabachnick & Fidel, 1983).

Kameoka and Sine (1977, cited by Cattell, 1978) suggested that extracted factors should also be tested to determine if they fit simple structure. Simple structure is assumed to have been achieved if all items not belonging to a factor have loadings less than .10. Factor two meets simple structure criterion but not factor one. It should be emphasized that this is a very stringent simple structure criteria, and a reliable factor which achieves this criteria is a highly significant factor.

TABLE 2

THREE FACTOR AND TWO FACTOR OBLIQUE SOLUTION WITH DIRECT OBLIMIN ROTATION; DELTA = 0 (H = COMMUNALITY)

	Three Factor				Two Factor		
Item/Factor	1	2	3	h	1	2	h
1.	-15	74	05	53	-17	76	52
2.	01	22	23	13	13	24	09
3.	-13	68	02	44	-16	70	44
4.	62	-08	10	43	68	-06	44
5.	38	52	-01	50	32	53	49
6.	31	61	07	60	29	64	60
7.	44	50	-03	53	37	59	52
8.	41	48	13	59	45	51	60
9.	21	57	08	47	20	59	47
10.	70	-08	14	57	77	-06	57
11.	42	02	18	28	52	04	28
12.	01	21	17	09	10	23	07
13.	08	-03	68	51	(49)	(01)	25
14.	66	01	-08	39	58	02	35
15.	59	-03	07	38	62	-01	38
16.	29	17	10	18	34	18	19
17.	24	08	30	24	42	10	21
18.	05	-06	68	48	(47)	(02)	21
19.	50	00	05	28	52	02	27
20.	34	44	18	32	18	44	27
21.	48	-06	05	25	51	-05	24
22.	-22	43	-04	19	-27	44	20
Item 13 & 18 Averaged					48	02	24

Note. Decimal points are omitted and loadings > .4 have been underlined.

Items 2 and 12 did not load on either of the two factors as indicated by the very low communality values. These two items made no contribution to the factors extracted and can be deleted from the scale.

The similarity between the present two factor solution and Harpur's solution using pooled data (Harpur et al., 1988) was determined using congruence coefficients. The factor loadings for all 22 items were used in the comparison in order to make the two solutions directly comparable. The congruence coefficients for the corresponding factors are highly significant, (0.94 and 0.98 respectively, $p < .001$), suggesting the factors in the two solutions are essentially equivalent.

TABLE 3

A COMPARISON OF TWO ESTIMATES OF RELIABILITY FOR THE THREE AND TWO FACTOR SOLUTION

	Factor 1	Factor 2	Factor 3
Multiple R-square			
Three Factor Solution	.855	.852	.718
Two Factor Solution	.867	.861	
SSL			
Three Factor Solution	3.306	2.995	1.243
Two Factor Solution	3.842	3.174	

DISCUSSION

Using a multimethod approach, two highly reliable factors were extracted from the data matrix. The extremely close correspondence between Templeman's and Harpur's solutions, derived using totally different methods, provides strong converging evidence in favour of a two factor interpretation of the PCL. The third factor in Templeman's three factor solution is probably a trivial low level factor.

The larger number of factors extracted in previous studies is due to an overextraction of factors. The reliance on a single factor extraction method could easily provide the wrong solution. We suggest a multimethod approach be used routinely to provide converging evidence as to the correct number of factors to retain.

Statistical methods can be used to indicate the upper bounds for the number of factors to retain. The very simple structure test, with the most stringent simple structure requirements, can give an estimate of the lower bound. Other methods, e.g. the Scree test and MAP test can then be used to narrow down the correct choice. Any good theoretical reason to reject a particular solution should be given serious consideration and no single factor retention criteria should be slavishly adhered to.

The two factors extracted are easily interpretable. The first factor, which is equivalent to Harpur et. al.'s second factor, reflects a pattern of long standing antisocial and/or criminal behaviors and lifestyle. The second factor represents personality traits and characteristics that are generally considered to be prototypical of the psychopath. The two factors are nonetheless quite highly correlated ($r = .56$). The PCL assesses criminal psychopathy by taking into account both the personality characteristics and the antisocial/criminal behavioral patterns of the individual. Among most incarcerated psychopaths, criminal behaviors generally covary with the psychopathic personality, and this accounts for the overlap of the two factors. The PCL assesses both traits, and such built in redundancy, in part, accounts for the robustness of the PCL, e.g. the prorated PCL score is still reliable and valid even when 3 or 4 items are not scored. However, incarcerated psychopaths who had escaped extensive formal involvement with the law and/or had

inadequate documented background and criminological information, may not score within the psychopathic range because of low scores on factor 1 (antisocial/criminal behaviors) items.

Ideally, psychopathy should be defined based on the underlying personality constructs alone. The instrument to measure psychopathy, therefore, should measure the underlying personality constructs relatively independent of specific behavioral manifestations. To do this, the assessor will have to do more than simply count behavioral bits. He/she will have to make inferences about the presence or absence of the personality constructs based on a general description of the expected behaviors rather than on the presence or absence of specific behaviors. The process may appear difficult and unreliable, but, as the reliability and validity of Factor 2 (personality characteristics) items have demonstrated, given clear instructions and rating criteria, and with appropriate training of the raters, such ratings can be done. It is conceivable that with an expansion of factor 2 items, a scale similar to factor 2 could be developed and used on its own to diagnose the criminal or non-criminal psychopath.

REFERENCES

Bartlett, M. S. (1950). Tests of significance in factor analysis. *British Journal of Psychology, 3*(2), 77-85.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88*(3), 588-606.

Cattell, R. B. (1978). *The scientific use of factor analysis in the behavioral and life sciences*. New York: Plenum Press.

Comrey, A. L. (1973). *A first course in factor analysis*. New York: Academic Press.

Comrey, A. L. (1978). Common methodological problems in factor analytic studies. *Journal of Consulting and Clinical Psychology, 46*, 648-659.

Everett, J. E. (1983). Factor comparability as a means of determining the number of factors and their rotation. *Multivariate Behavioral Research, 18*, 197-218.

Gorsuch, R. L. (1983). *Factor analysis* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hakstian, R. A., & Muller, V. J. (1973). Some notes on the number of factor problem. *Multivariate Behavioral Research, 8*, 461-475.

Hakstian, R. A., Rogers, W. T., & Cattell, R. B. (1982). The behaviour of number-of-factors rules with simulated data. *Multivariate Behavioral Research, 17*, 193-219.

Hare, R. D. (1980). A research scale for the assessment of psychopathy in criminal populations. *Personality and Individual Differences, 1*, 111-119.

Hare, R. D. (1985). *The Psychopathy Checklist*. Unpublished manuscript, University of British Columbia, Vancouver, Canada.

Harmon, H. H. (1976). *Modern factor analysis* (3rd ed.). Chicago: University of Chicago Press.

Harpur, T. J., Hakstian, A. R., & Hare, R. D. (1988). The factor structure of the Psychopathy Checklist. *Journal of Consulting and Clinical Psychology, 56*, 741-747.

Humphreys, L. G., & Ilgen, D. R. (1969). Note on a criterion for the number of common factors. *Education and Psychological Measurement, 29*, 571-578.

Klinteberg, B, Humble, K., & Shalling, B. (1992). Personality and psychopathy of males with a history of early criminal behaviour. *European Journal of Personality, 6*, 245-266.

Kosson, D. S., Nichols, S., & Newman, J. P. (1990). Evaluating the construct validity of psychopathy in black and white male inmates: 3 preliminary studies. *Journal of Abnormal Psychology, 99*, 250-259.

Lawley, D. N., & Maxwell, A. E. (1963). *Factor analysis as a statistical method.* London: Butterworth.

Montanelli, R. G., & Humphreys, L. G. (1976). Latent roots of random data correlation matrices with squared multiple correlations on the diagonal: A Monte Carlo study. *Psychometrika, 41*, 341-348.

Mulaik, S. A. (1972). *The foundations of factor analysis.* New York: McGraw Hill.

Raine, A. (1985). A psychometric assessment of Hare's checklist for psychopathy on an English prison population. *British Journal of Clinical Psychology, 24*, 247-258.

Revelle, W., & Rocklin, T. (1979). Very simple structure: An alternative procedure for estimating the optimal number of interpretable factors. *Multivariate Behavioral Research, 14*, 403-414.

SAS Institute. (1985). *SAS user's guide: Statistics, version 5 edition.* Cary, NC: SAS Institute.

Tabachnick, B. G., & Fidel, L. S. (1983). *Using multivariate statistics.* Philadelphia: Harper & Row.

Templeman, R., & Wong, S. (1987). A proposed factor structure of the Psychopathy Checklist. *Annual Meeting of the Canadian Psychological Association, 28(2a).* (Abstract No. 609)

Ten Berge, J. M. F. (1986). Rotation to perfect congruence and cross-validation of component weights across populations. *Multivariate Behavioral Research, 21*, 41-64.

Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometrika, 41*, 321-327.

Wong, S. (1988). Is Hare's psychopathy checklist reliable without the interview? *Psychological Report*, 62, 931-934.

Footnotes

1. A portion of the present sample was used in their analyses.